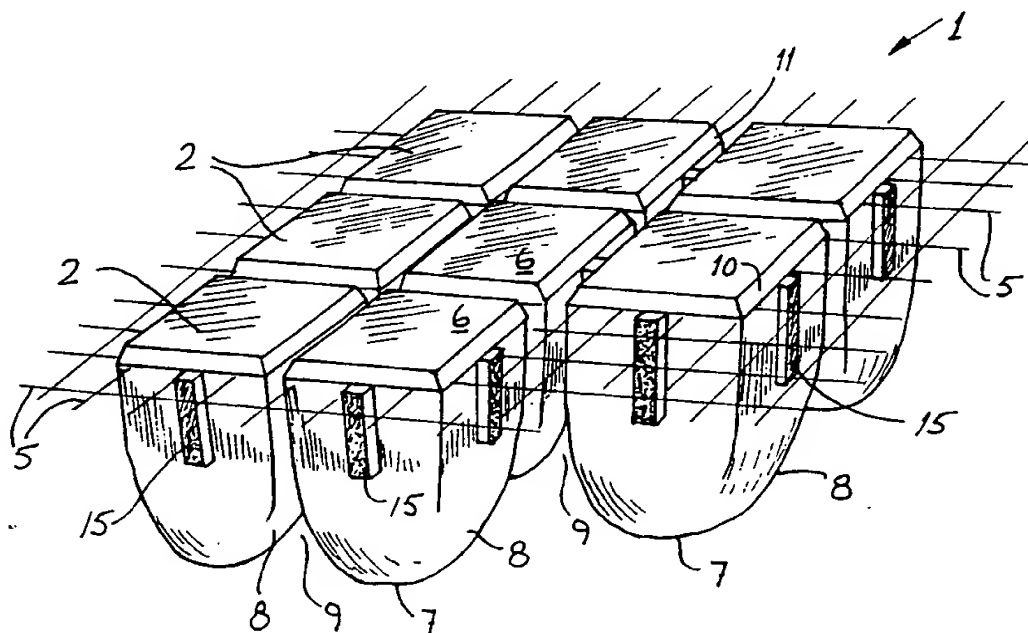


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/IE92/00014 <b>(22) International Filing Date:</b> 12 October 1992 (12.10.92)  <b>(30) Priority data:</b> 3535/91                   11 October 1991 (11.10.91)   IE 916/92                   23 March 1992 (23.03.92)    IE  <b>(71) Applicant (for all designated States except US):</b> EOLAS THE IRISH SCIENCE AND TECHNOLOGY AGENCY [IE/IE]; Glasnevin, Dublin 9 (IE).  <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only) :</b> CLARKE, Cameron, John, Ross [GB/IE]; The Round House, Bellevue Hill, Delganey, Wicklow (IE).  <b>(74) Agents:</b> O'CONNOR, Donal, H. et al.; Cruickshank & Co., 1 Holles Street, Dublin 2 (IE).		<b>(81) Designated States:</b> AT, AU, BB, BG, BR, CA, CH, CS, DE, DK, ES, FI, GB, HU, JP, KP, KR, LK, LU, MG, MN, MW, NL, NO, PL, RO, RU, SD, SE, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, SN, TD, TG).  <b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>

**(54) Title:** A PAVING ASSEMBLY**(57) Abstract**

A paving assembly (1) comprises a plurality of paving elements (2) interconnected by a reinforcing and interconnecting mesh (5) of plastics material. Adjacent paving elements (2) are joined by frangible links (15) which assist in spacing the elements (2) to define interstices (9) to receive bedding sand. The links (15) have fault line (16) along which the links (15) may be broken to accommodate articulation between adjacent paving elements (2), on fitting. A mechanical interlock is formed when the paving is in place and the faces of the link posts (15) re-engage. In some cases a paving assembly (100) may comprise paving elements (101) which do not have a joining mesh.

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"A paving assembly"

The invention relates to paving, including any surface covering of any suitable material such as brick, concrete or the like.

5 In one type of paving system which is widely used, large preformed paving slabs are laid side by side to pave an area. The advantage of such large slabs is that a regular shaped area may be paved relatively quickly. There are also considerable disadvantages, however, as there are difficulties in handling and laying the slabs because of  
10 their size and weight. Further, the slabs are generally relatively easily damaged and broken.

In a second type of paving system, a large number of small paving bricks or tiles are laid to fill an area and while such tiles are much lighter, easy to handle, and less  
15 likely to break than large paving slabs, the time taken to lay a particular area with such small tiles is generally much greater than with larger slabs.

This invention is directed towards providing a new paving system which will overcome the disadvantages with known  
20 paving systems.

According to the invention there is provided a paving assembly for paving an area comprising:-

25 a plurality of paving elements, each element having an upper face, a lower face and sidewall means extending between the upper and lower faces; and

a joining mesh extending between at least groups of adjacent paving elements;

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the joining mesh extending between the elements intermediate the upper and lower faces thereof.

5 In a preferred embodiment of the invention the assembly includes frangible link means between adjacent paving elements. Preferably, the link means is integrally formed with the paving elements. Preferably, the link means includes fault means along which the link means may be broken.

10 In one embodiment of the invention the sidewall means includes an inwardly converging lower sidewall portion for bedding in a paving-receiving bed.

Preferably, the sidewall means includes an upper portion adjacent to the upper face of the paving element.

15 In one embodiment the upper sidewall portion diverges outwardly from the upper face of the paving element.

In one arrangement the joining mesh is located substantially at a transition between the upper and lower portions of the sidewall means.

20 Preferably, the joining mesh comprises a plurality of intersecting longitudinal and transverse joining mesh elements. Ideally, the joining mesh is at least partially flexible to permit restricted relative movement between the paving elements during paving. Typically, the joining mesh is of a plastics material.

25 Preferably, the paving elements are of a settable, typically cementitious, material.

In one arrangement each paving element is substantially rectilinear in transverse cross-section.

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The invention also provides a method of forming a paving assembly of the invention, the method comprising the steps of:-

- filling a mould box with a mould-forming material;
- 5 inserting a first former tool into the mould-forming material to form a grid of lower paving element shapes;
- laying a joining mesh across the lower paving element grid;
- pouring settable material into the grid to a level
- 10 above the joining mesh;
- prior to setting, inserting a second former tool into the settable material to form the upper portion of the paving elements; and
- when set, discharging the paving assembly thus formed
- 15 from the mould box.

Preferably mould-forming material comprises sand.

In another aspect the invention provides a method of forming a paving assembly of the invention, the method comprising the steps of:-

- 20 moulding a first lower part of a plurality of paving elements in a mould;
- laying a joining mesh at least between adjacent paving elements; and

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5 moulding a second upper part of the paving elements over the joining means and the lower part of the paving elements to form, when set, a paving assembly comprising a plurality of paving elements interconnected by joining mesh.

The invention also provides a paving assembly whenever formed by the method of the invention.

According to another aspect the invention provides a paving assembly for paving an area comprising:-

10 a plurality of paving elements; and  
frangible link means between adjacent paving elements.

In one embodiment of the invention the link means is integrally formed with the paving elements.

15 Preferably the link means includes fault means along which the link means may be broken.

In one arrangement the paving elements are of a settable material. Preferably, the paving elements are of a cementitious material. In one case, each paving element  
20 is substantially rectilinear in transverse cross-section.

The invention also provides one or a plurality of paving elements of the assembly.

The invention will be more clearly understood from the following description thereof given by way of example only  
25 with reference to the accompanying drawings in which:-

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Fig. 1 is a perspective view of part of one paving assembly according to the invention;

Fig. 2 is a perspective view of one paving element of the paving assembly of Fig. 1;

5 Fig. 3 is a side view of a detail of the paving assembly;

Fig. 4 is a plan view of the detail of Fig. 3;

Figs. 5 to 8 are plan views illustrating typical layouts of paving according to the invention;

10 Fig. 9 is a cross-sectional view illustrating one method of forming the paving assembly of Figs. 1 to 4;

Figs. 10 to 14 are side cross sectional views of another method of forming a paving assembly according to the invention;

15 Figs. 15 to 19 are side cross-sectional views of some typical paving elements of paving assemblies;

Fig. 20 is a perspective view of part of another paving assembly according to the invention;

Fig. 21 is a side view of the assembly of Fig. 20;

20 Fig. 22 is a plan view of the assembly of Fig. 20;

Figs. 23 to 25 are respectively perspective, side and plan vies of part of a further paving assembly;

Fig. 26 is a plan view of part of another paving assembly;

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Fig. 27 is a perspective view of another paving assembly;

Fig. 28 is a perspective view of one paving element of the assembly of Fig. 27; and

5 Fig. 29 is a perspective view of a detail of the paving assembly of Fig. 27.

10 Referring to the drawings and initially to Figs. 1 to 4 thereof, there is illustrated portion of a paving assembly according to the invention and indicated generally by the reference numeral 1. The paving assembly 1 comprises at least two, and in this case a plurality of, paving elements 2 which are interconnected by a joining means. In this case the joining means comprises a reinforcing and interconnecting mesh 5 of plastics material extending  
15 between at least groups of adjacent paving elements 2 of the paving assembly 1.

Each paving element 2 has an upper thread face 6, a lower bedding-in face 7 and sidewall means extending between the faces 6,7.

20 In this case each of the paving elements 2 includes a lower inwardly converging sidewall portion 8 for bedding in a paving receiving bed of sand or the like which fills interstices 9 between adjacent paving elements 2 in use. An upper sidewall portion 10 of each paving element 2  
25 converges inwardly and upwardly to define receiving areas 11 between adjacent paving elements which are filled with sand which travels up through the interstices 9.

Referring particularly to Figs. 3 and 4 adjacent paving elements 2 are joined, when moulded, by frangible links or



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webs 15 which assist in spacing the paving elements 2 apart to define the interstices for receiving bedding sand or the like. The links 15 may be formed with a vertically extending fault line(s) 16 along which the links 15 may be cracked to allow for articulation between adjacent paving elements 2, on fitting. The links 15 act as a true mechanical interlock because, when fitted, the parts of the links 15 attached to the paving elements 2 interengage. The links 15 allow individual paving elements to be separated while preventing undesirable backlash following manufacture.

The mesh material 5 is sufficiently rigid to allow the paving elements 2 to be adequately supported during transport and storage and on laying on a paving bed, but sufficiently flexible to permit a restricted amount of relative movement between adjacent paving elements 2 as may, in some cases, be required by the contour of the area to be covered by the paving system. Further, the material of the mesh is sufficiently ductile to facilitate stretching to accommodate any subsidence or earth movement.

The paving assembly 1 is laid in a generally conventional manner by laying a paving bed of sand, and laying the paving assembly 1 of the invention comprising the plurality of paving elements 2 joined together by a mesh material onto the bed. When the paving elements 2 are in the desired position, the gaps 11 between the upper exposed edges of the paving elements 2 may, if necessary, be filled with mortar or the like to give a pleasing aesthetic finish to the paved area and to form an additional interlock between the paving elements.

Using the paving system of the invention an area may be speedily laid with paving, particularly in cases where

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intricate designs are required. Because of the relatively small unit size of the paving elements and the reinforcing properties provided by the interconnecting mesh, the paving system of the invention has high strength, in use. Further, for a given area it is anticipated that a paving assembly of the invention would be considerably lighter than large slabs and, consequently, substantially less concrete is required. Because of the relatively small unit size of paving elements which are interconnected the paving assembly of the invention is not prone to damage either in handling or in use.

Some complex and intricate patterns which may be formed by using the paving assemblies of the invention are illustrated in Figs. 5 to 8. It will, of course, be appreciated that these are only illustrative examples from the practically unlimited range that would be available by providing paving assemblies comprising suitably sized and shaped paving elements.

Referring particularly to Fig. 9 to form the paving assembly 1 according to the invention typically a paving forming material such as concrete is first poured into a lower mould part 17 having a plurality of paving element forming regions 18. While the concrete is still wet, joining means in the form of mesh material 5 is laid over the top of the concrete in the lower mould part 17 to extend between adjacent mould elements 18. A second mould part 19 is then placed in position above the first mould part 17. Concrete is poured into the second mould part 19 and extends throughout the mesh 5 and onto the exposed surface of the lower paving element part in the lower mould part 17. When the paving forming material has set the upper mould part 19 is released and the first lower mould part 17 is also released, leaving a plurality of

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paving elements 2 which are interconnected by the joining mesh material 5 extending therebetween.

Referring to Figs. 10 to 14, a paving assembly may also be produced using a mould box 20, a first former tool 21 and  
5 a second former tool 22. The mould box 20 is first loaded with a bed 23 of sand into which the first former tool 21 is inserted to form a desired plurality of paving element recesses 25. A mesh 5 of plastics or the like material is laid on top of the recesses 25 as illustrated in Fig. 11.  
10 Concrete is then poured into the recesses 25 up to a level above the mesh 5. While the concrete is still wet the second former tool 22 is pushed into the top of the concrete to form a plurality of interconnected paving elements 2. When set, the paving assembly may be readily  
15 removed from the mould box 20 by, for example, tipping over the box. The sand 23 may be re-used and may, if desired, be treated to speed up the moulding process. For example, the sand may be heated and/or may contain a release agent. Because of the flexibility between the  
20 paving elements, low tolerance and accuracy are not essential. Consequently, sand or the like may be used as the mould-forming material.

The paving assembly according to the invention offers a substantial reduction in material, laying and  
25 manufacturing costs of paving.

Because an area is paved using a large number of relatively small interconnected paving elements which are produced in a form which allows them to be readily easily transported and dispensed, manufacturing accuracy is no  
30 longer required. This represents substantial savings in mould cost. There is also a substantial reduction in the weight of paving required to pave a particular area. Depending on the arrangement of individual paving elements

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for a given area, the weight of a paving assembly according to the invention could be as little as 25% of the weight of a conventional paving. Thus, large sheets of paving assemblies according to the invention, for example, up to 0.5m<sup>2</sup> or more may be readily handled by one person. Because of the arrangement of paving elements, when they are put in place they are tamped into position and the bedding sand fills the interstices thus eliminating the need for a separate operation of filling the joints between paving elements with sand. Further, intricate patterns can be easily laid by an unskilled worker.

Another major advantage is that the paving assemblies may be easily used on ground which is not level. The assembly may be arranged to follow deliberate contours such as gulleys etc. Because of the smaller area of the paving elements, they are virtually unbreakable and can be easily rolled up and possibly mechanically laid from a roll. Depending on the type of mesh material used, a desired size and shape of assembly may be readily cut simply by cutting the mesh between individual elements to a desired shape.

While some novel methods for forming a paving assembly according to the invention have been described above it is envisaged that conventional moulding methods may be adapted for forming a paving assembly of the invention.

Referring to Figs. 15 to 19 there is illustrated typical examples of different shapes of paving elements 61, 62, 63, 64, 65 that may be used to form paving assemblies according to the invention.

The paving element 61 has a substantially flat upper face 70, downwardly diverging upper sidewall portions 71, and

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lower sidewall portions 72 which converge downwardly towards a flat lower face portion 73. The element 61 is in this case of generally rectilinear shape when viewed in plan from above or below.

- 5 The paving elements 62, 63, 64, 65 are similar to the paving element 61, the main differences relating to the angles of inclination or curvature of various sidewall portions.

10 A plurality of any one of the elements 61, 62, 63, 64, 65 or any suitable similar elements are interconnected by a joining means comprising an interconnecting and possibly reinforcing mesh material extending between adjacent paving elements of a paving assembly. By virtue of the arrangement of paving elements and joining mesh a paving  
15 assembly is readily formed, handled, and used. A paving assembly thus formed may be readily coiled into a roll and cut to any desired size and shape.

Referring to Figs. 20 to 22, there is illustrated a further paving assembly 80 according to the invention  
20 which is similar to the assembly of Figs. 1 to 4 and like parts are assigned the same reference numerals. In this case there are no frangible webs or links and the interstices 11 are filled with sand or mortar. A similar paving assembly 85 is illustrated in Figs. 23 to 25 and  
25 like parts are again assigned the same reference numerals. In this case the angles of the upper and lower sidewall portions 8,10 are larger for improved bedding-in and decreased weight.

Referring to Fig. 26, another paving assembly 90 is  
30 illustrated. In this case adjacent paving elements 2 butt together and the elements 2 are shaped to define interstices or gaps 79 for receiving bedding sand or the

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like which fills the interstices 79 between the paving elements 2, in use.

Referring to Figs. 27 to 28 there is illustrated part of another paving assembly 100 according to the invention which consists of a plurality of paving elements 101 also according to the invention. Each paving element 101 is in this case of generally rectilinear shape and adjacent elements 101 are linked, when manufactured, by frangible links or webs 102 which are integrally formed with the paving elements 101. The links 102 in this case are formed with V-shaped fault lines 103 along which the links 102 may be broken to form link parts 105 having mating surfaces 106 which, when interengaged, in use, with corresponding mating surfaces 106 of the link part 105 of another paving element 101 form a very effective mechanical interlock. The interlock substantially prevents relative vertical movement between adjacent paving elements 101, in use.

In the case of the paving of Figs. 27 to 28 there is not necessarily any interconnecting joining mesh.

The paving elements may be formed with links during manufacture and subsequently the links severed along the fault lines to be re-assembled by a user. It will of course be appreciated that the paving elements may be of any desired shape and configuration. Similarly, the links may be positioned in any desired location and may be of any desired shape and configuration.

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CLAIMS

1. A paving assembly for paving an area comprising:-  
  
a plurality of paving elements, each element  
having an upper face, a lower face and sidewall  
5 means extending between the upper and lower faces;  
and  
  
a joining mesh extending between at least groups  
of adjacent paving elements;  
  
the joining mesh extending between the elements  
10 intermediate the upper and lower faces thereof.
2. A paving assembly as claimed in any preceding claim  
including frangible link means between adjacent  
paving elements.
3. A paving assembly as claimed in claim 2 wherein the  
15 link means is integrally formed with the paving  
elements.
4. A paving assembly as claimed in claim 2 or 3 wherein  
the link means includes fault means along which the  
link means may be broken.
- 20 5. A paving assembly as claimed in any preceding claim  
wherein the sidewall means includes an inwardly  
converging lower sidewall portion for bedding in a  
paving-receiving bed.
- 25 6. A paving assembly as claimed in any preceding claim  
wherein the sidewall means includes an upper portion  
adjacent to the upper face of the paving element.

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7. A paving assembly as claimed in claim 6 wherein the upper sidewall portion diverges outwardly from the upper face of the paving element.
- 5 8. A paving assembly as claimed in claim 6 or 7 wherein the joining mesh is located substantially at a transition between the upper and lower portions of the sidewall means.
- 10 9. A paving assembly claimed in any preceding claim wherein the joining mesh comprises a plurality of intersecting longitudinal and transverse joining mesh elements.
- 15 10. A paving assembly as claimed in any preceding claim wherein the joining mesh is at least partially flexible to permit restricted relative movement between the paving elements during paving.
11. A paving assembly as claimed in any preceding claim wherein the joining mesh is of a plastics material.
- 20 12. A paving assembly as claimed in any preceding claim wherein the paving elements are of a settable material.
13. A paving assembly as claimed in any preceding claim wherein the paving elements are of a cementitious material.
- 25 14. A paving assembly as claimed in any preceding claim wherein each paving element is substantially rectilinear in transverse cross-section.



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15. A paving assembly substantially as hereinbefore described with reference to the accompanying drawings.
- 5 16. A method of forming a paving assembly as claimed in any of claims 1 to 15 comprising the steps of:-
- filling a mould box with a mould-forming material;
- inserting a first former tool into the mould-forming material to form a grid of lower paving element shapes;
- 10 laying a joining mesh across the lower paving element grid;
- pouring settable material into the grid to a level above the joining mesh;
- 15 prior to setting, inserting a second former tool into the settable material to form the upper portion of the paving elements; and
- when set, discharging the paving assembly thus formed from the mould box.
- 20 17. A method as claimed in claim 16 wherein the mould-forming material comprises sand.
18. A method of forming a paving assembly as claimed in any preceding claim comprising the steps of:-
- moulding a first lower part of a plurality of paving elements in a mould;

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laying a joining mesh at least between adjacent paving elements; and

5 moulding a second upper part of the paving elements over the joining means and the lower part of the paving elements to form, when set, a paving assembly comprising a plurality of paving elements interconnected by joining mesh.

10 19. A method of forming a paving assembly substantially as hereinbefore described with reference to the accompanying drawings.

20. A paving assembly whenever formed using a method as claimed in any of claims 16 to 19.

21. A paving assembly for paving an area comprising:-

15 a plurality of paving elements; and  
frangible link means between adjacent paving elements.

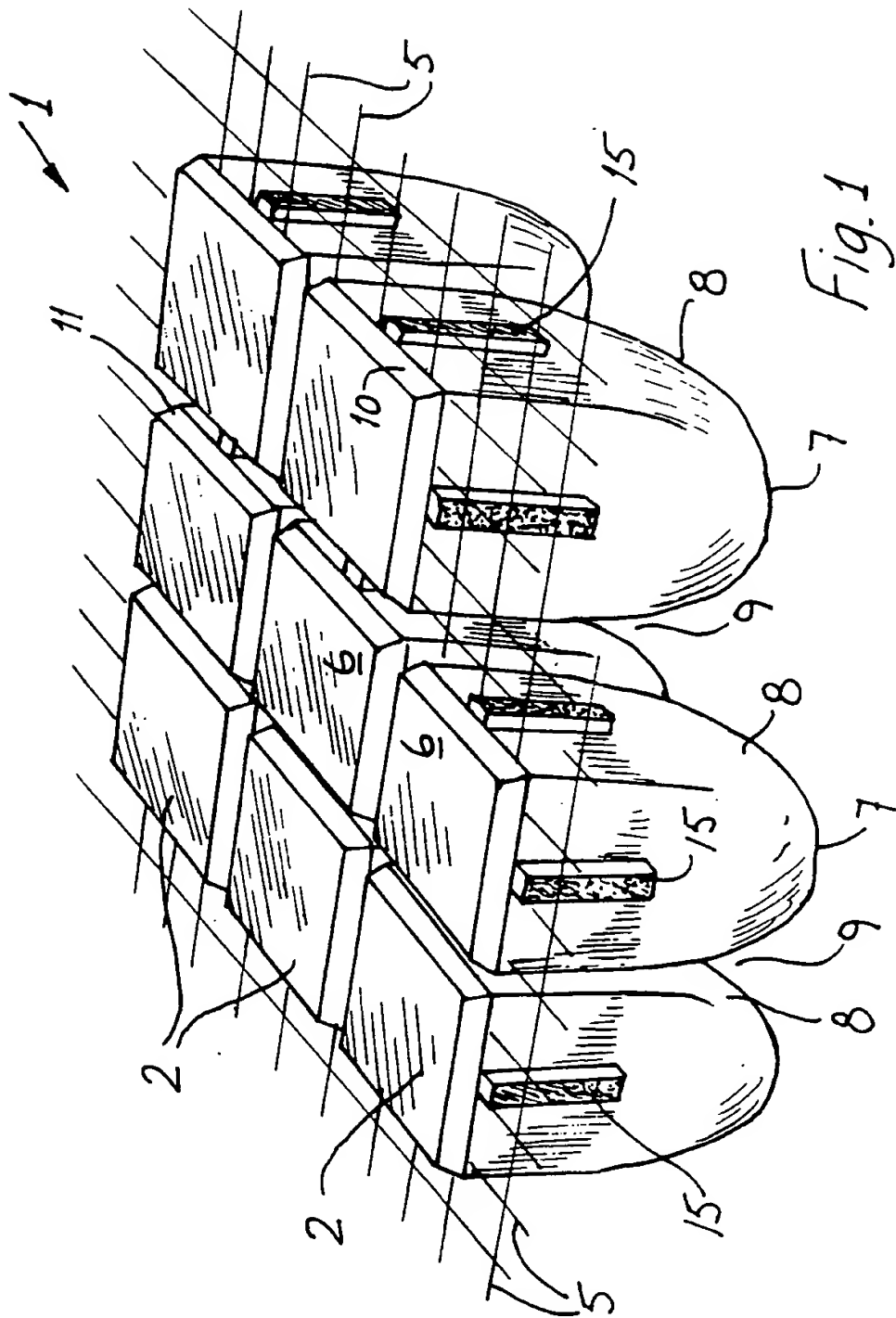
22. A paving assembly as claimed in claim 21 wherein the link means is integrally formed with the paving elements.

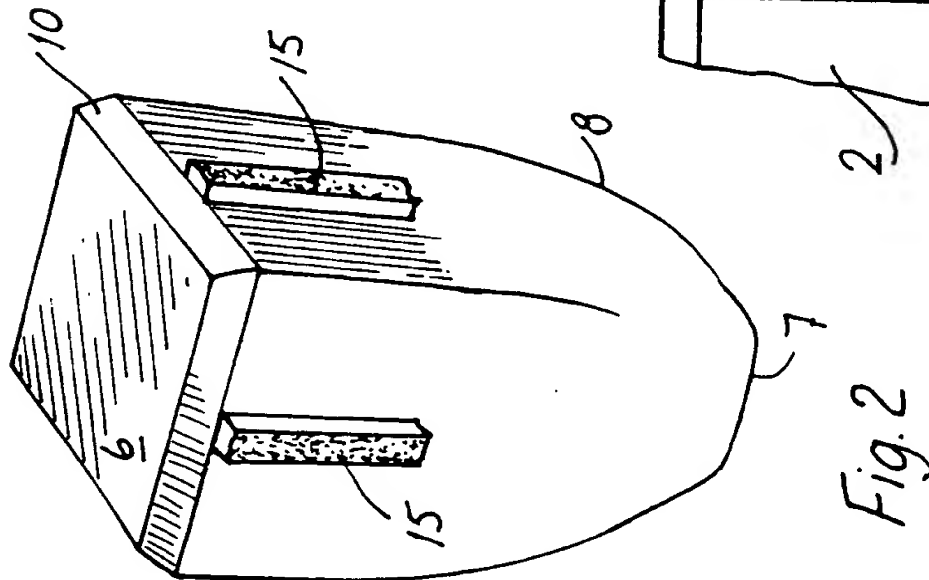
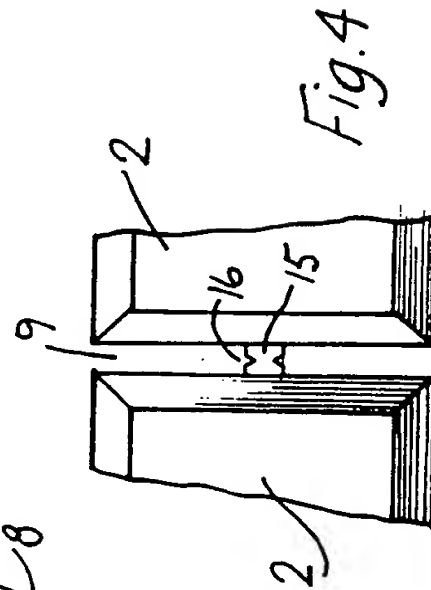
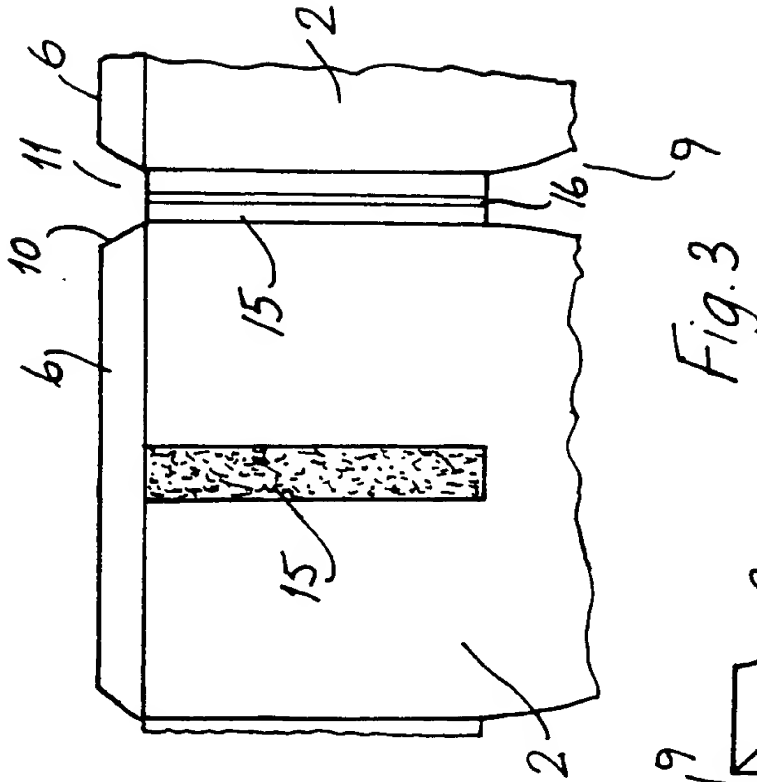
20 23. A paving assembly as claimed in claim 21 or 22 wherein the link means includes fault means along which the link means may be broken.

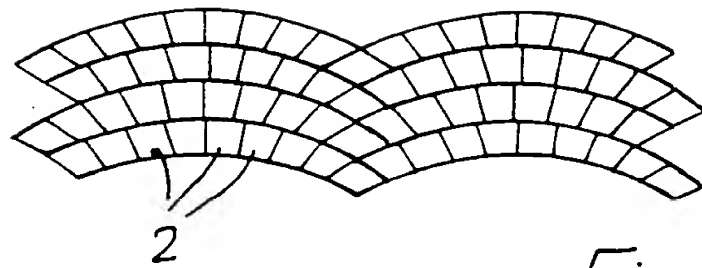
25 24. A paving assembly as claimed in any of claims 21 to 23 wherein the paving elements are of a settable material.

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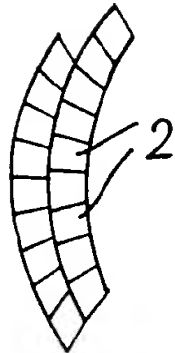
25. A paving assembly as claimed in any of claims 21 to 24 wherein the paving elements are of a cementitious material.
- 5 26. A paving assembly as claimed in any of claims 21 to 25 wherein each paving element is substantially rectilinear in transverse cross-section.
27. A paving assembly substantially as hereinbefore described with reference to Figs. 27 to 29 of the accompanying drawings.
- 10 28. A paving element of the assembly of any of claims 21 to 27.



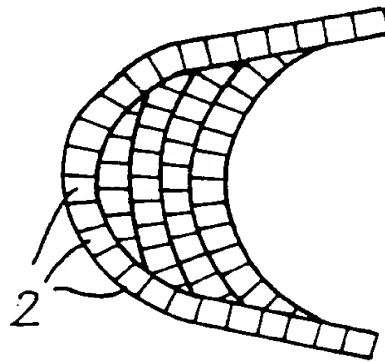




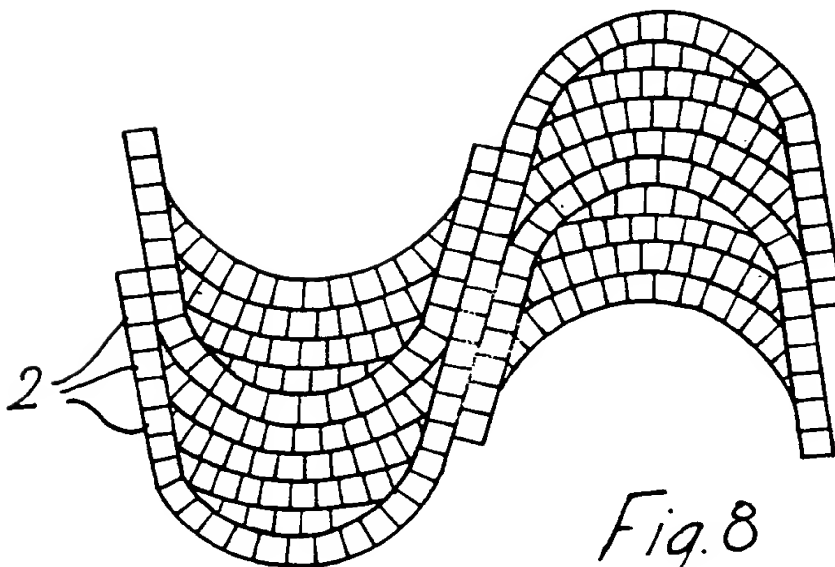
*Fig. 5*



*Fig. 7*



*Fig. 6*



*Fig. 8*

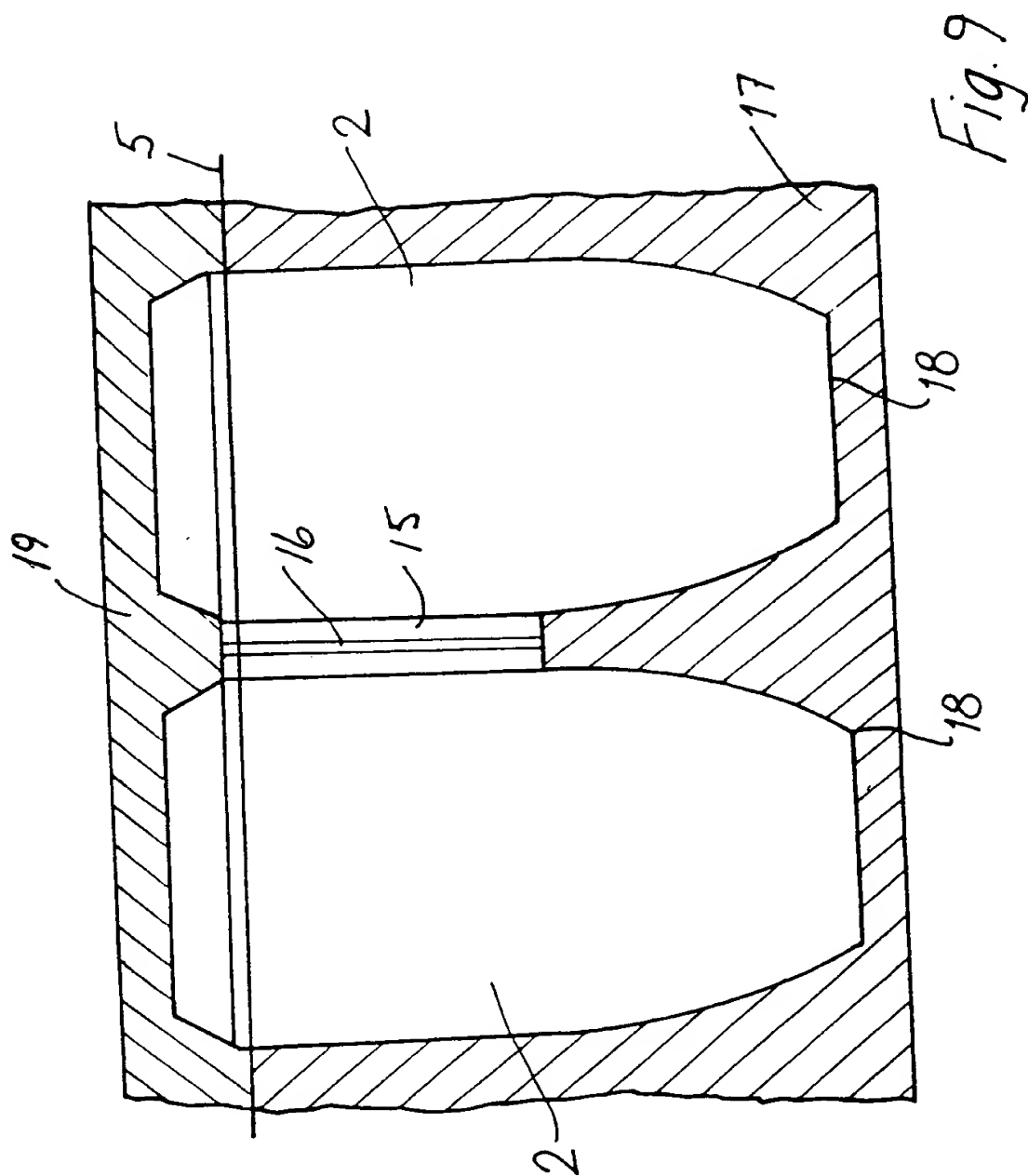


Fig. 9

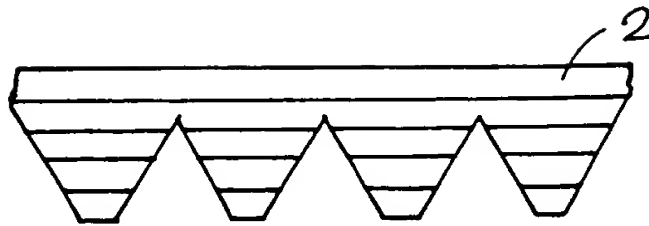


Fig. 10

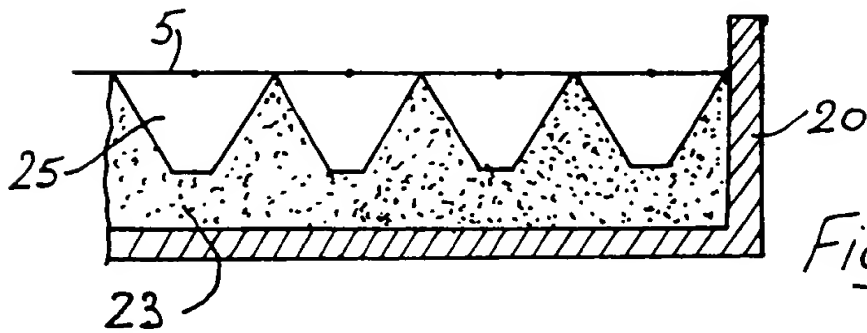


Fig. 11

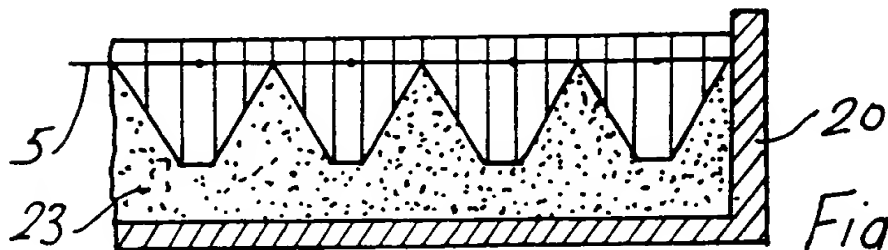


Fig. 12



Fig. 13

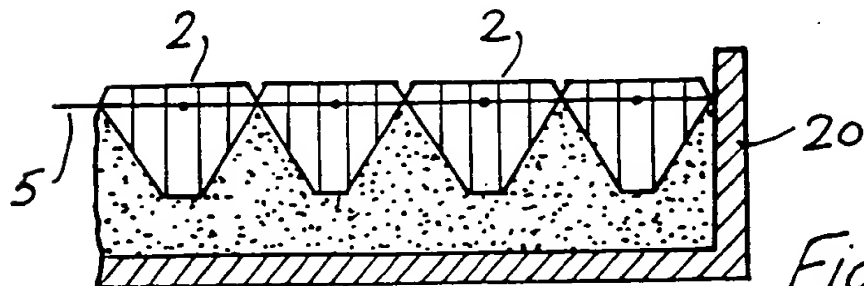
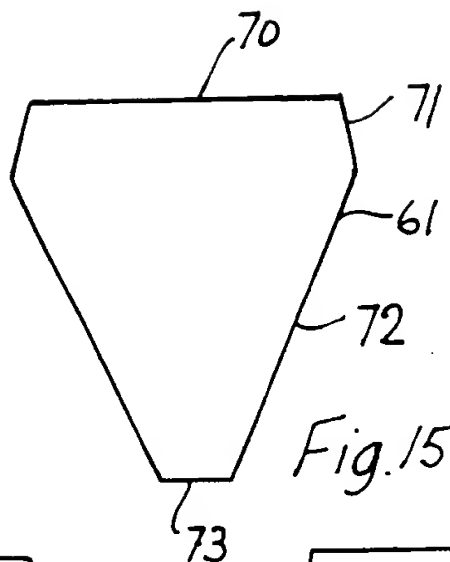


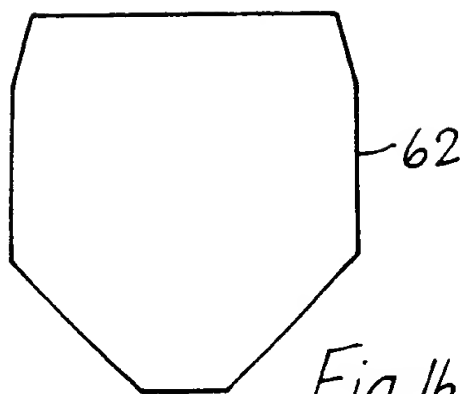
Fig. 14



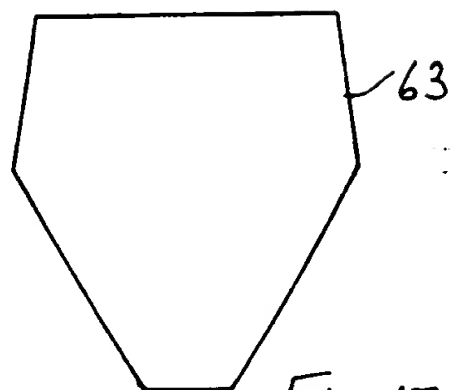
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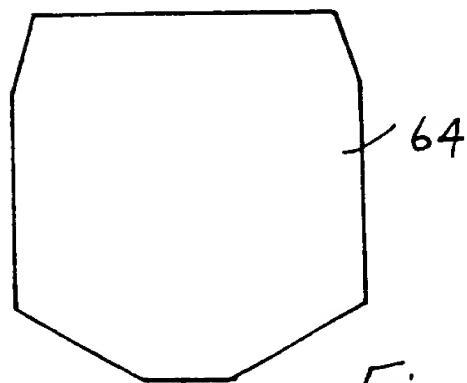
*Fig. 15*



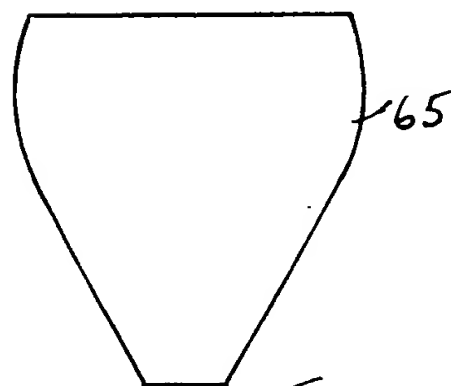
*Fig. 16*



*Fig. 17*

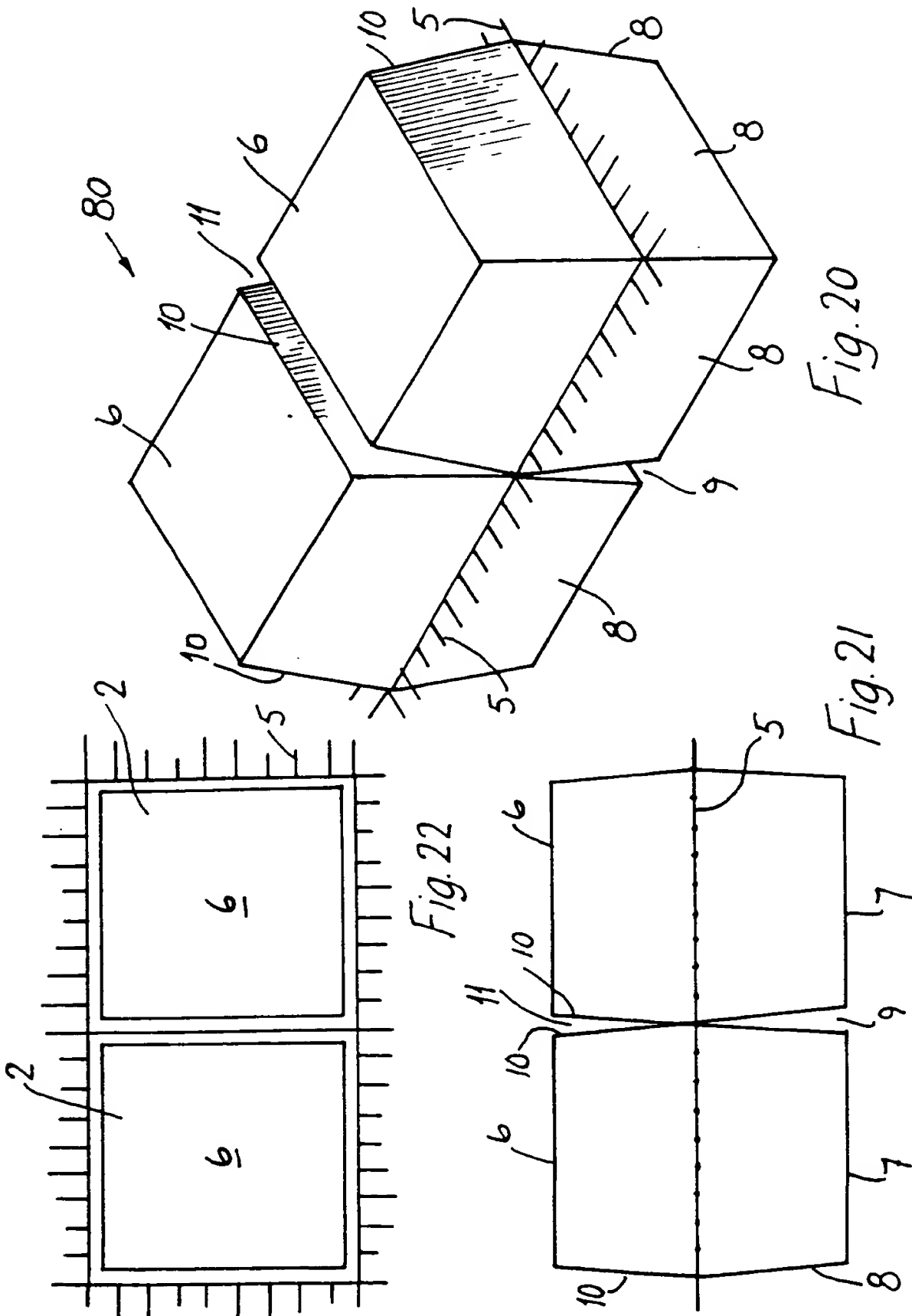


*Fig. 18*



*Fig. 19*

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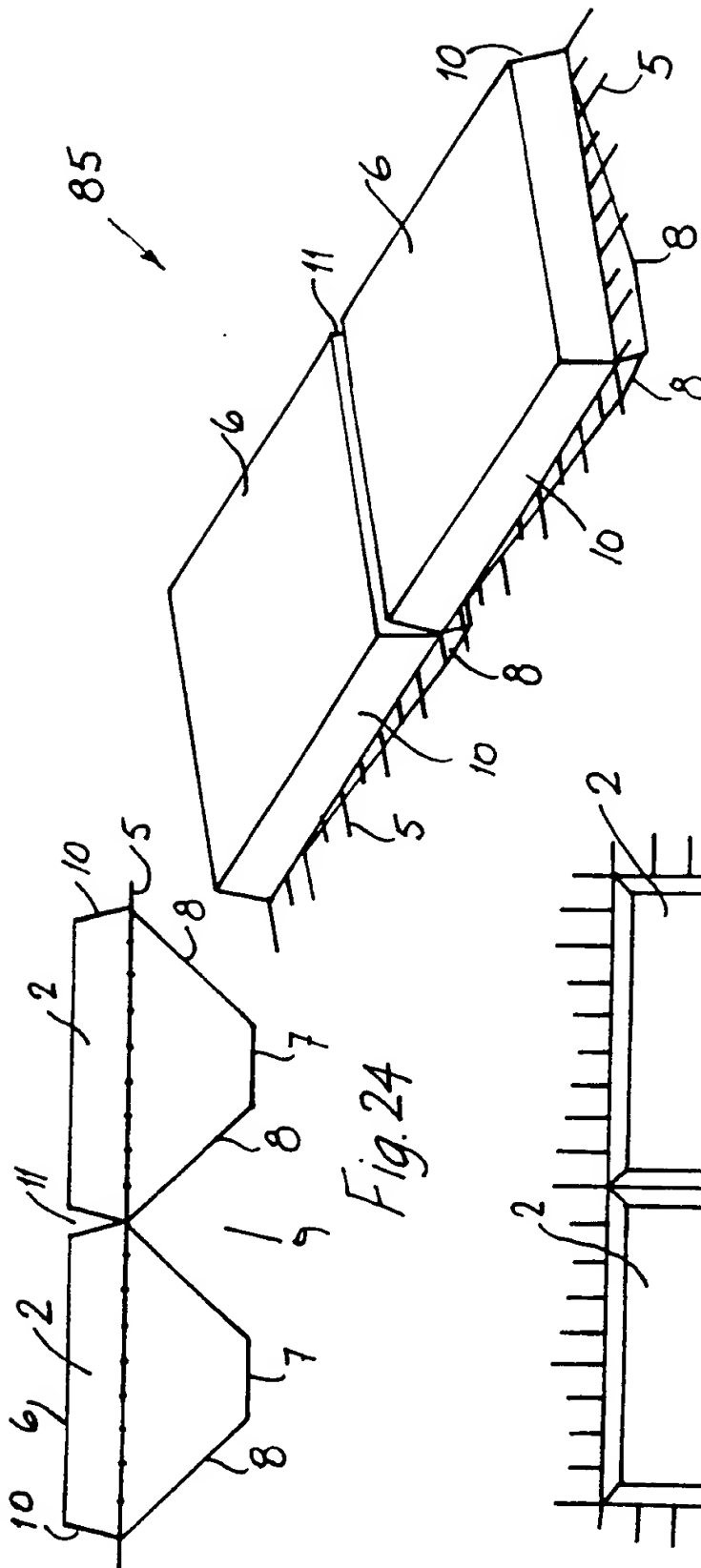


Fig. 23

Fig. 24

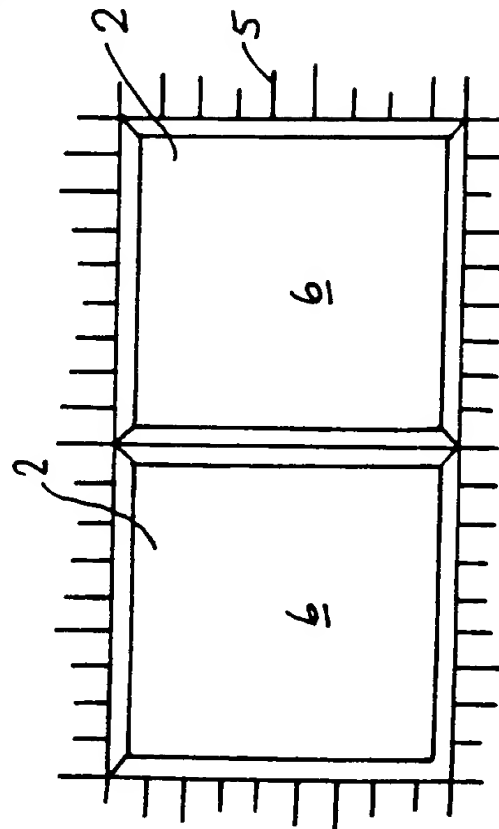


Fig. 25

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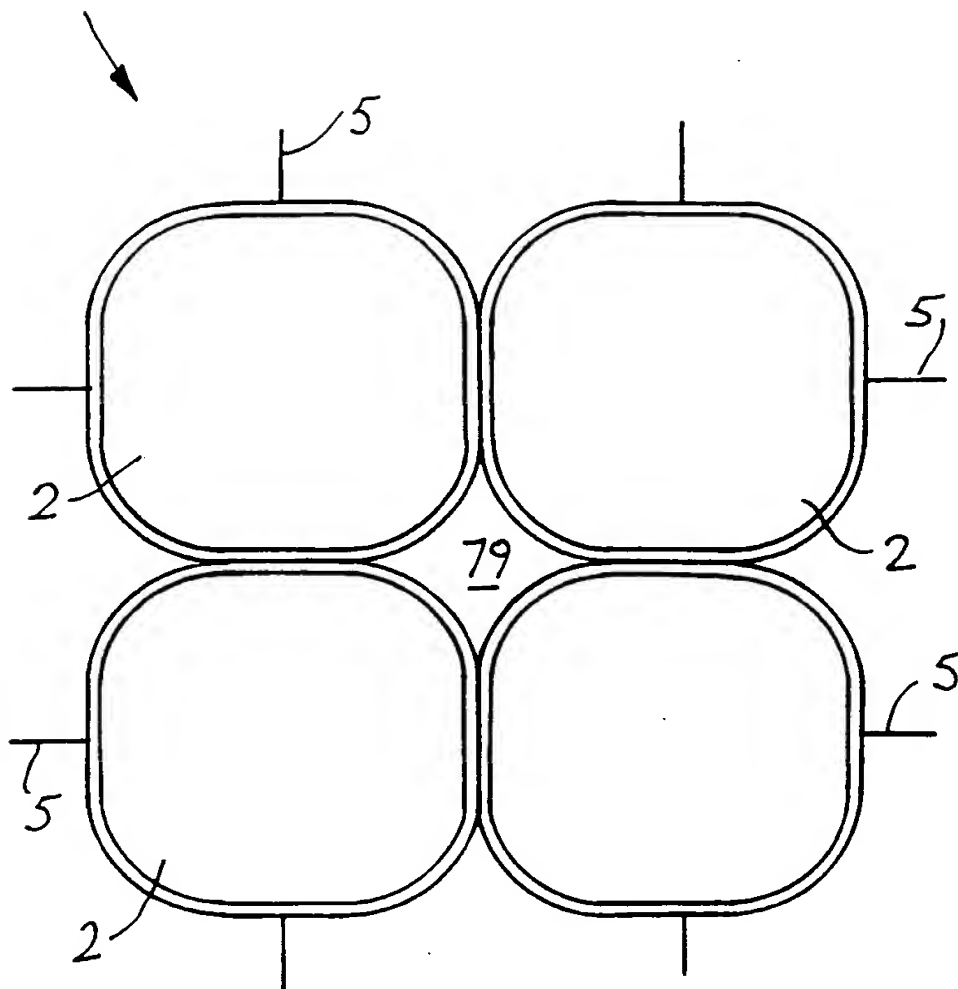


Fig. 26

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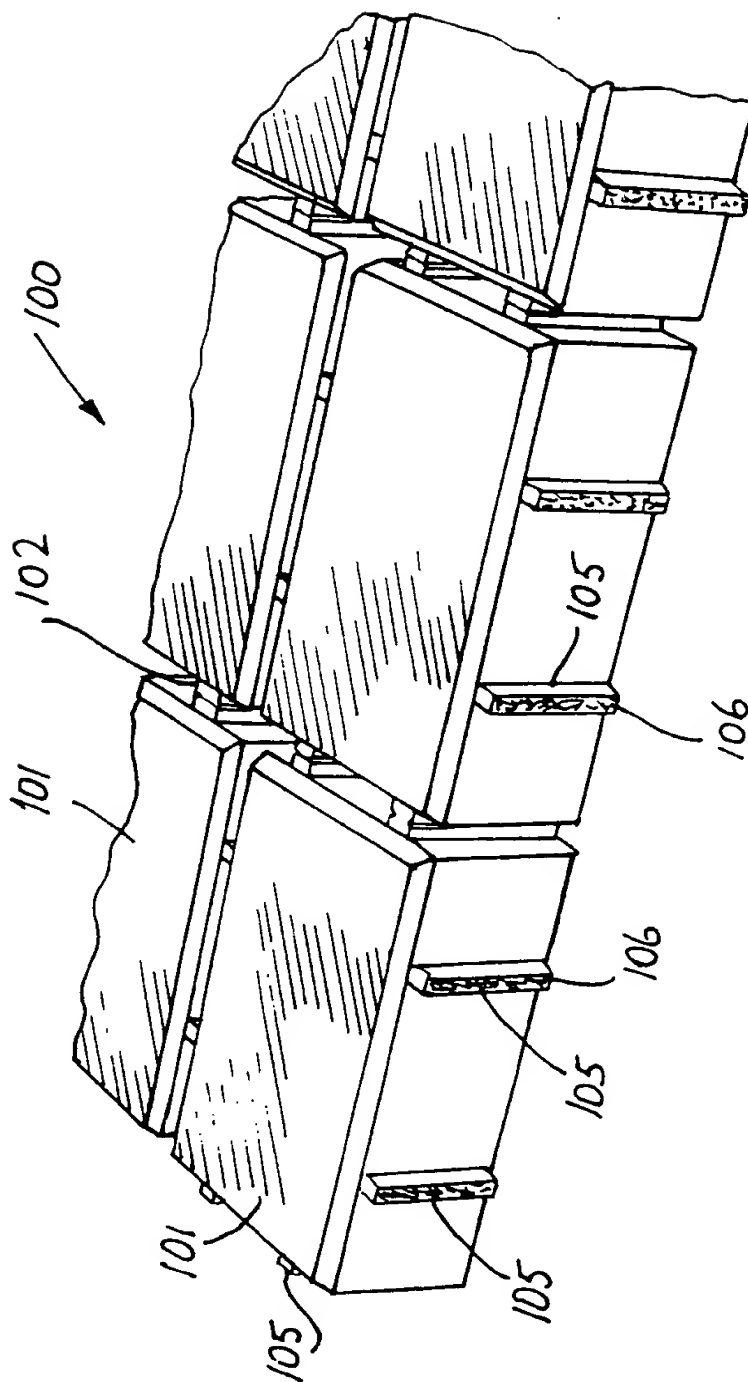
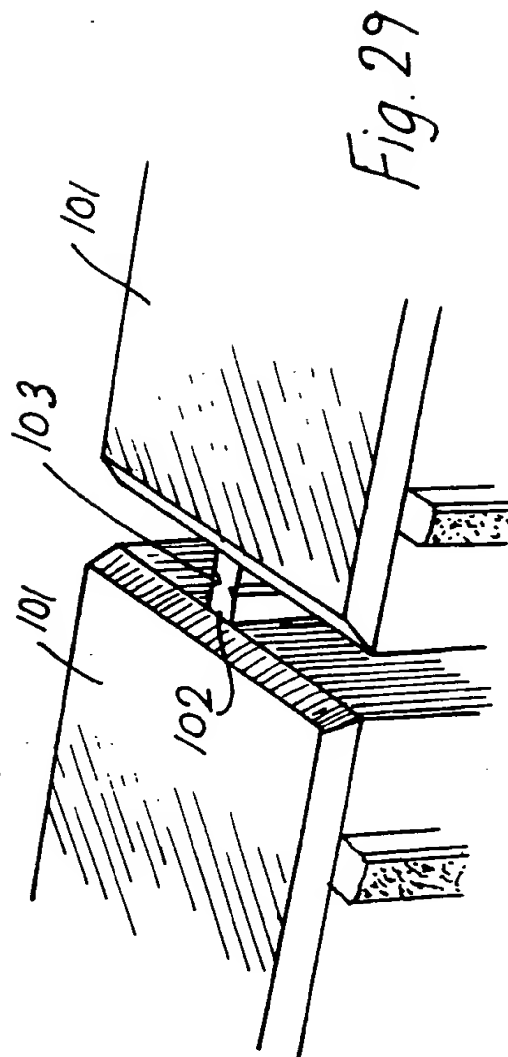
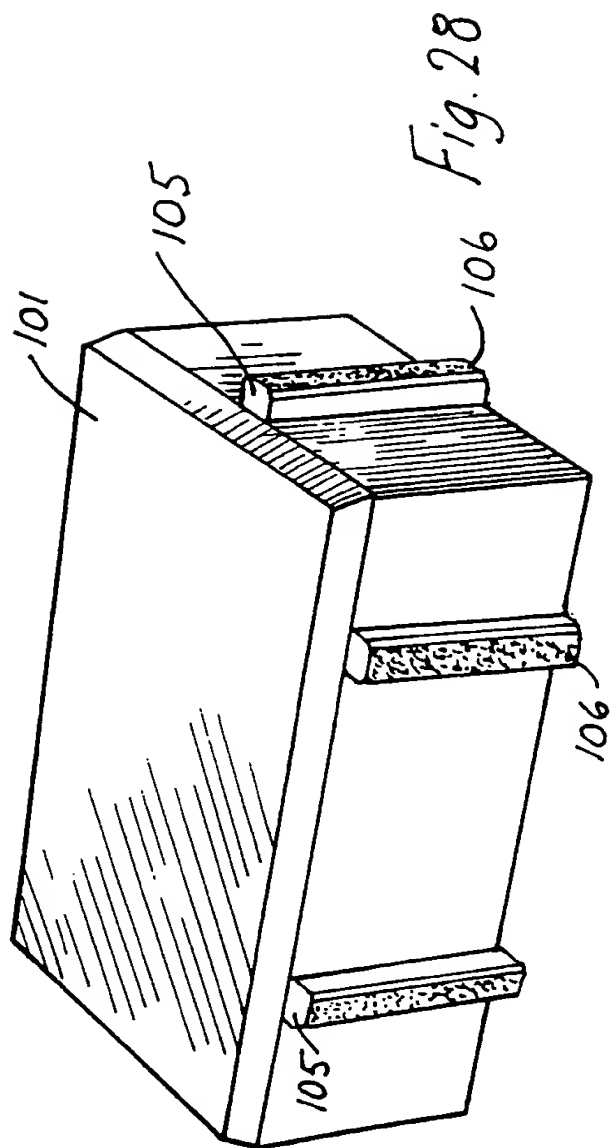


Fig. 27

SUBSTITUTE SHEET



## INTERNATIONAL SEARCH REPORT

International Application No

PCT/IE 92/00014

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate)		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.Cl. 5 E01C5/08;	E01C5/06;	B28B7/34; B28B23/00
II. FIELDS SEARCHED		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
Int.Cl. 5	E01C ;	B28B ; E02B
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
III. DOCUMENTS CONSIDERED TO BE RELEVANT <sup>9</sup>		
Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
X	EP,A,0 004 364 (SF-VOLLVERBUNDSTEIN) 3 October 1979	1-3, 9-15, 21, 22, 24-28 5-7
Y	see the whole document ---	
Y	FR,A,713 483 (PELUSO) 28 October 1931	5-7
A	see the whole document ---	1, 12, 13
X	GB,A,2 009 280 (SHINTARO SATO) 13 June 1979	1-4, 9-15, 18, 19 16, 17
Y	see the whole document ---	
Y	CH,A,155 708 (MAYER) 16 September 1932 see page 1, right column, line 3 - line 12 ---	16, 17
		-/--
<sup>10</sup> Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
07 JANUARY 1993	04. 02. 93	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	DIJKSTRA G.	

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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		Relevant to Claim No.
Category	Citation of Document, with indication, where appropriate, of the relevant passages	
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Y	DE,A,3 023 305 (LARSEN) 22 January 1981 see page 4, line 6 - line 14; figure 1 -----	23



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IE 9200014  
SA 65664

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on  
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